

REMARKS

Applicants gratefully acknowledge the indication by the Examiner that claim 4 would be allowable, if amended to overcome the rejection under 35 U.S.C. §112, first paragraph. However, for the reasons outlined below, Applicants respectfully traverse the rejection under 35 U.S.C. §112, first paragraph.

Claims 1-7 and 32-44 are pending in this application. This Amendment currently amends claims 1, 4, 32, and 33, and adds new claims 34-44. Claims 8-31, which are withdrawn from present consideration, are canceled without prejudice or disclaimer. No new matter is added to currently amended claims 1, 4, 32, and 33, or to new claims 34-44. Claims 1, 4, 32, and 33 are currently amended to merely clarify the subject matter of the claims and in no way narrows the scope of the claims in order to overcome the prior art or for any other statutory purpose of patentability. Notwithstanding any claim amendments of the present Amendment or those amendments that may be made later during prosecution, Applicants' intent is to encompass equivalents of all claim elements. Reconsideration in view of the foregoing amendments and the following remarks is respectfully requested.

Claims 1-7, 32, and 33 stand rejected under 35 U.S.C. §112, first paragraph.

Claims 1, 5, 7, 32, and 33 stand rejected under 35 U.S.C. §102(b) as anticipated by JP 10-312971 to Sunakawa et al. (hereinafter, Sunakawa JP), which corresponds to U.S. Patent No. 6,348,096 to Sunakawa et al. (hereinafter, Sunakawa '096). Claims 2, 3, and 6 stand rejected under 35 U.S.C. §103(a) as unpatentable over Sunakawa in view of U.S. Patent No. 6,194,742 to Kern et al. (hereinafter, Kern).

These rejections are respectfully traversed in view of the following discussion.

I. THE CLAIMED INVENTION

The claimed invention, as described in independent claim 1, discloses a group III nitride compound semiconductor device that comprises a substrate including an upper surface, an undercoat layer uniformly formed on an entirety of the upper surface of the substrate, in which an upper surface of the undercoat layer is covered with convex portions, each of the convex portions

being shaped like a truncated hexagonal pyramid, and group III nitride compound semiconductor layers formed on the undercoat layer.

The claimed invention, as described in independent claim 32, discloses a group III nitride compound semiconductor device that comprises a substrate including an upper surface, an undercoat layer uniformly formed on an entirety of the upper surface of the substrate, in which a cross-section of an upper surface of the undercoat layer is characterized by a sectionally trapezoid shape, and group III nitride compound semiconductor layers formed on the undercoat layer.

An aspect of the present invention is the uniform formation of an undercoat layer that grows over the entirety of the substrate surface without breaks or discontinuities in a direction perpendicular to the substrate surface to form a textured surface with flat regions and sloped regions on a micron scale.

II. THE 35 U.S.C. §112, FIRST PARAGRAPH, REJECTION

Claims 1-7, 32, and 33 are rejected under 35 U.S.C. §112, first paragraph, because the Examiner alleges that the disclosure is not enabling. The Examiner further alleges that the feature of the recited undercoat layer is doped with Mg at a concentration no smaller than $10^{20} / \text{cm}^3$ and the truncated hexagonal pyramid patterns are formed through annealing the Mg-doped undercoat without the using of any masks are critical or essential to the practice of the invention, but not included in the claim(s) is not enabled by the disclosure.

The Examiner particularly cites page 14, line 18 through page 15, line 9, to support his allegation. In relevant part, the Specification recites, "That is, when GaN is used as the material of the undercoat layer and doped with magnesium (Mg) densely, an undercoat layer having convex portions each shaped like a truncated hexagonal pyramid is formed by an MOCVD method. The doping quantity of Mg is preferably selected to be not smaller than $10^{20} / \text{cm}^3$. If the doping quantity of Mg is smaller than $10^{20} / \text{cm}^3$, it is impossible to generate any convex portion shaped like a truncated hexagonal pyramid or" (Specification, page 14, line 21 to page 15, line3).

Applicants respectfully traverse the rejection of claims 1-7, 32, and 33 under 35 U.S.C.

§112, first paragraph, for the following reasons.

Applicants respectfully submit that the Examiner's rejection is predicated on the logical conjunctive premise that if the undercoat layer is formed of GaN and doped with magnesium (Mg), then a doping quantity of $10^{20}/\text{cm}^3$ is essential to the practice of the invention.

However, the Examiner's logical conjunctive premise is fallacious because the invention includes much more than an undercoat layer formed of GaN, which is doped with magnesium (Mg), as evidenced by the following.

Page 12, lines 8-12, of the Specification clearly recite, "the undercoat layer is not particularly limited so long as a group III nitride compound semiconductor can be grown on the undercoat layer. The undercoat layer is preferably made of a group III nitride compound semiconductor. It is especially preferable to employ an undercoat layer of AlN."

Page 12, lines 13-21, of the Specification then continue to describe the various group III nitride compound semiconductors that may comprise the undercoat layer, "When an undercoat layer made of a group III nitride compound semiconductor is used, the group III nitride compound semiconductor includes a quaternary compound semiconductor represented by $\text{Al}_x\text{Ga}_y\text{In}_{1-x-y}\text{N}$ ($0 < X < 1$, $0 < Y < 1$, $0 < X + Y < 1$), a ternary compound semiconductor represented by $\text{Al}_x\text{Ga}_{1-x}\text{N}$ ($0 < X < 1$) and a binary compound semiconductor such as AlN, GaN and InN. When a sapphire substrate is used, AlN is especially preferably used as the group III nitride compound semiconductor formed on the sapphire substrate."

Therefore, it is clear that the invention describes and enables group III nitride compound semiconductor materials other than GaN.

In addition, the first embodiment of the invention, which is described from page 26, line 2 to page 31, line 3, provides an enabling disclosure in which neither an undercoat of GaN, nor a doping of the undercoat layer is disclosed. In particular, page 27, line 16 to page 28, line 5 recites, "Then, while TMA and NH_3 are introduced, an undercoat layer 12 of AlN is grown on the substrate 11 at the substrate temperature by an MOCVD method. On this occasion, when the undercoat layer 12 is of AlN is grown as a film with a predetermined thickness while TMA and NH_3 are introduced in the condition TMA:30 $\mu\text{mol/min}$ and NH_3 : SLM, the surface of the AlN

undercoat layer 12 exhibits a texture structure similar as shown in Figs. 1 and 2. Similarly, when the flow rate of NH_3 is selected to be in a range of from 1/2 to 1/3 on the aforementioned condition, the surface of the undercoat layer 12 is made to a trapezoid shape in section as shown in Fig. 3."

Therefore, it is clear that the invention describes and enables group III nitride compound semiconductor materials other than GaN, and group III nitride compound semiconductor materials, which are not doped.

For at least the reasons outlined above, Applicants respectfully submit that an undercoat layer comprising GaN, which is doped with magnesium (Mg), is not critical or essential to the practice of the invention. Withdrawal of the rejection of claims 1-7, 32, and 33 under 35 U.S.C. §112, first paragraph, is respectfully solicited.

III. THE PRIOR ART REJECTIONS

A. The Sunakawa Reference

Figs. 3(a-d) of Sunakawa JP correspond to Figs. 5(a-d) of Sunakawa '096. Fig. 5(a) of Sunakawa '096 shows the initial stage of the GaN 45 epitaxial growth forming facet structures 46 in the growing areas 34 (col. 8, lines 41-43). As epitaxy is continued, the GaN layer 45 develops facet structures 46 until the facet structures cover the mask 33, as shown in Fig. 5(b) (col.8, lines 44-46). Subsequently, continuing epitaxy causes the facet structures 46 to be buried in the GaN layer 45, as shown in Fig. 5(c) (col. 8, lines 47-48). Ultimately, a GaN layer 45 about 100 μm thick having a flat surface was produced, as shown in Fig. 5(d) (col. 8, lines 49-50).

Claim 1 recites at least the features of "an undercoat layer uniformly formed on an entirety of said upper surface of said substrate, in which an upper surface of said undercoat layer is covered with convex portions, each of said convex portions being shaped like a truncated hexagonal pyramid."

Claim 32 recites at least the feature of "an undercoat layer uniformly formed on an entirety of said upper surface of said substrate, in which a cross-section of an upper surface of said undercoat layer is characterized by a sectionally trapezoid shape."

The substrate 41 of Sunakawa '096 is covered by a mask 33, which divides the upper

surface of the substrate into growing areas for subsequent growth of a GaN layer. The GaN layer of Sunakawa '096 initially grows in the growing areas to form facet structures 46, which are separated from one another by the mask, as shown in Fig. 5(a). Further growth of the GaN layer of Sunakawa '096 results in the overgrowth of the mask by the facet structures 46, as shown in Fig. 5(b). Continued growth of the GaN layer 45 of Sunakawa '096 results in the gradual formation of a flat surface, as the facet structures 46 are buried in the growing GaN layer 45.

In contrast, the claimed invention describes in claims 1 and 32 "an undercoat layer uniformly formed on an entirety of said substrate" That is, the undercoat layer of the claimed invention is formed without variation in detail, continuously, over the spatial extent of the entirety of the substrate. In the claimed invention, there is no overgrowth of the discontinuities imposed by the mask of Sunakawa. An obvious advantage of the present invention is the absence of depositing a mask layer and subsequently patterning the mask layer as is required by Sunakawa '096.

Therefore, Sunakawa '096 does not disclose, teach or suggest "an undercoat layer uniformly formed on an entirety of said upper surface of said substrate, in which an upper surface of said undercoat layer is covered with convex portions, each of said convex portions being shaped like a truncated hexagonal pyramid," as recited in claim 1 or "an undercoat layer uniformly formed on an entirety of said upper surface of said substrate, in which a cross-section of an upper surface of said undercoat layer is characterized by a sectionally trapezoid shape," as recited in claim 32.

For at least the reasons outlined above, Applicant respectfully submits that Sunakawa does not disclose, teach, or suggest every feature of claims 1 and 32. Accordingly, Sunakawa does not anticipate, or render obvious, the subject matter of claims 1 and 32, and claims 5, 7, and 33, which depend from claims 1 and 32. Withdrawal of the rejection of claims 1, 5, 7, 32, and 33 under 35 U.S.C. §102(b) as anticipated by Sunakawa is respectfully solicited.

B. The Kern Reference

Kern discloses an interfacial layer 16 (identified as the Mg-doped GaN undercoat layer (16) in the Office Action on page 4, lines 14-15) that is deposited on top of a buffer layer 14,

which is formed on a substrate 12, prior to growth of an n-type (GaN:Si) layer 18, an active region 10, and a p-type layer 22 (col. 3, lines 49-51 and Fig. 3).

Claim 1 recites at least the features of "an undercoat layer uniformly formed on an entirety of said substrate, in which an upper surface of said undercoat layer is covered with convex portions, each of said convex portions being shaped like a truncated hexagonal pyramid."

Kern does not cure the deficiencies of Sunakawa. Nowhere does Kern teach or suggest that the upper surface of the interfacial layer 16, allegedly corresponding to the claimed invention's undercoat layer, "is covered with convex portions, each of said convex portions being shaped like a truncated hexagonal pyramid" as recited in claim 1.

For at least the reasons outlined above, Applicant respectfully submits that Sunakawa and Kern, either individually or in combination, do not teach or suggest every feature of claim 1. Accordingly, Sunakawa and Kern either individually or in combination fail to render obvious the subject matter of claim 1, and claims 2, 3, and 6, which depend from claim 1 under 35 U.S.C. §103(a). Withdrawal of the rejection of claims 2, 3, and 6 under 35 U.S.C. §103(a) as unpatentable over Sunakawa in view of Kern is respectfully solicited.

IV. CONCLUSION

In view of the foregoing, Applicants submit that claims 1-7 and 32-44, all the claims presently pending in the application, are patentably distinct over the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

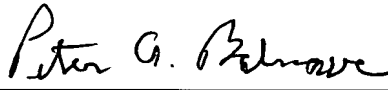
Serial No. 09/885,046
Docket No. T36-133525M/KOH

12

The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,

Date: 9/17/03



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